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Improved Fusarium resistance, increased feed digestibility, and optimized photosynthesis – development activities at Sejet Plant Breeding in the research project ReTraQue

As part of our continuous efforts to enhance the development and selection of new varieties, we at Sejet Plant Breeding actively participate in numerous projects with great dedication. These projects often involve collaborations with other industrial partners and academic research institutes. One of the major projects we engaged in, ended in 2023, was ReTraQue (Resistance-Traits-Quality). Its primary focus was on developing plants with improved Fusarium resistance, increased feed digestibility, and enhanced yield through optimized photosynthesis.

The project received support from the Innovation Fund Denmark (IFD) through their Grand Solutions program and was initiated by Crop Innovation Denmark (CID). Collaborating with the University of Copenhagen (KU), Aarhus University (AU), Danespo, DLF, and Nordic Seed, we aimed to develop new genomic breeding techniques, specifically the so called New Genomic Techniques (NGTs), notably the precision mutagenesis technique CRISPR/Cas, for future use in breeding contexts (Figure 1).

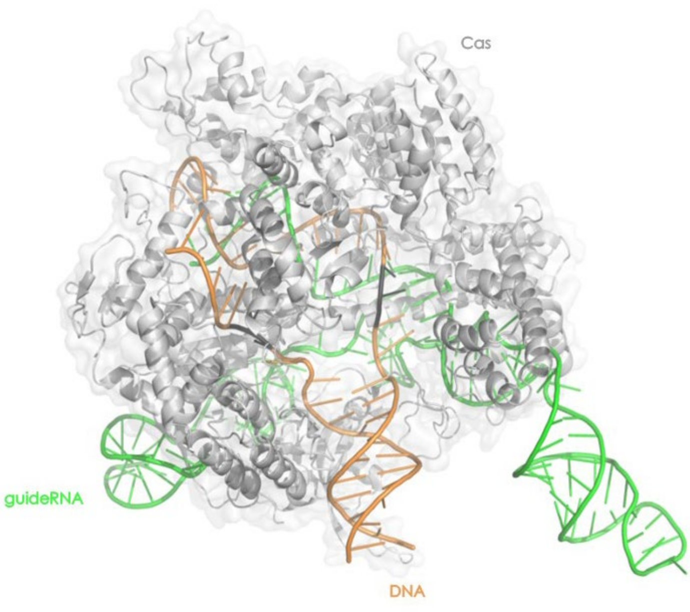

Figure 1 – NGT, specifically a gray Cas enzyme in complex with a green guideRNA molecule, acting on inducing a mutation in an orange DNA strand.

These techniques are intended for generating new genetic variations accurately and precisely, feeding into our breeding programs. The plants generated using these techniques are equivalent to those produced through conventional mutagenesis, either through irradiation or chemical mutagenesis, resulting in numerous mutations randomly scattered across the plant's genome. Conventional mutagenesis requires extensive screening efforts to identify plants precisely containing the mutations in the genes of interest. This process is time-consuming as subsequent backcrossing is necessary to eliminate unwanted background mutations. The use of these new techniques avoids such complications by precisely creating the desired single mutation at the exact position of interest. Therefore, we recognize significant potential in employing NGTs in future breeding endeavors, also acknowledging the limitations in scaling up these technologies. One of the major limitations is the requirement for an effective and robust protocol for plant production using tissue culture. As tissue culture serves as the starting point for developing new varieties at Sejet Plant Breeding, we already possess a highly competent and well-established laboratory team with extensive expertise in this field. Therefore, it was natural for us to invest a significant part of our commitment in the project to optimize protocols for the so-called anther cultures in barley and wheat. The work was very successful, and with the results from the project, we have significantly streamlined our winter wheat breeding (Figure 2).

At present, the biggest obstacle to applying NGTs in breeding contexts is the European legislation, categorizing NGT as traditional GMOs despite their equivalence to conventional mutagenesis. Efforts are underway at a European level to deregulate the use of NGT category 1 plants, expectedly implemented as early as 2024. If this becomes reality, the project equips us as a breeding company with a crucial tool for our ongoing efforts to develop superior varieties.

Figure 2 – On the left; a plant taken directly from tissue culture. On the right; field trials in barley and wheat at Sejet Plant Breeding, overlooking Horsens Fjord.

One prerequisite for utilizing NGTs is precise knowledge of where in the plant's genome a mutation needs to occur to yield the desired effect. Conventional mutagenesis can serve as a good starting point to screen for areas on the DNA that might impact traits like disease resistance or specific quality parameters. With the aim of having such a tool available, we also invested a significant portion of our project efforts in close collaboration with Nordic Seed, KU, and AU to develop mutant populations in both barley and wheat through conventional mutagenesis (Figure 3).

Figure 3 – A section of the mutant population in wheat displaying diversity in spike appearance.

These populations have been logistically managed for routine use in our breeding programs, and promising mutations for improved feed digestibility have already been identified within these populations. Together with the plants obtained at both AU and KU using NGT, demonstrating compelling results in increased feed digestibility, improved Fusarium resistance, and optimized photosynthesis, these plants from the populations will hopefully soon contribute to the crossbreeding work at Sejet Plant Breeding, benefiting farmers and the animals and humans reliant on our products.